Executive Summary

King County and the City of Seattle have prepared this facilities plan to meet United States Environmental Protection Agency (USEPA) grant requirements and Washington Department of Ecology (Ecology) requirements for an engineering report. The purpose of the project is to reduce combined sewer overflows (CSOs) to south, east, and west Lake Union and to Elliott Bay at the existing Denny Way Regulator Station. The County and City were awarded a grant for this project by USEPA in 1995.

Project Need

Existing System

Much of Seattle is served by a combined sewer system rather than separate sanitary and storm sewers. During wet weather, when the volume of sanitary sewage and stormwater entering the combined sewers exceeds the system capacity, the system is designed to overflow at several designated CSOs.

Operation of the wastewater conveyance system in the eastern portion of the Denny Way/Lake Union drainage basin is shared by the County and the City. Both of their systems discharge CSOs from this drainage basin into Lake Union. In addition, the County owns a major CSO facility that discharges into Elliott Bay at the Denny Way Regulator Station in Myrtle Edwards Park. Currently, CSO discharges occur at this location about 50 times per year, resulting in an annual average discharge volume of 405 million gallons (MG).

Figure ES-1 shows the main conveyance facilities in this basin, including the location of the County's Denny Way CSO discharge. King County's existing wastewater conveyance and treatment system serving the Denny basin project area consists of a wastewater treatment plant at West Point, the Elliott Bay Interceptor, the Interbay Pump Station, the Denny Way Regulator Station and Outfall, the Lake Union Tunnel, and the Dexter Regulator Station. The City's system consists of a new interceptor pipeline beneath Fairview and Eastlake Avenues on the east side of Lake Union.

Regulatory Requirements

Ecology has adopted a number of regulations pertaining to municipal waste discharges, including CSOs (WAC Chapter 173-245). The regulations require that CSOs be controlled "such that an average of one untreated discharge may occur per year." In addition, CSO treatment is defined as being the equivalent of primary treatment.

King County staff and consultants have met with Ecology staff to discuss the proposed Denny Way CSO Project and how it complies with state regulations. The project will function as a storage and transfer project during most storms, with flows transferred to the West Point Treatment Plant once capacity is available. At the West Point plant, the flows will generally receive secondary treatment. On average, about 50 percent of the annual CSO volume that enters the tunnel will be transferred to West Point.

During larger storms, flows from the tunnel will be treated at the Elliott West CSO Control Facility and discharged through the Elliott West Outfall. Floatables will be removed, and these flows will be disinfected and dechlorinated. During the largest storms (on average, once per year), flows will exceed the pumping capacity of the Elliott West facility, and there will be discharge of untreated CSO through the new outfall extension at the Denny Way Regulator Station.

Ecology has concurred informally that this combined approach, using both CSO storage/transfer and at-site treatment, appears to meet applicable state regulations. Through the National Pollutant Discharge Elimination System (NPDES) permitting process, the state will establish monitoring and reporting requirements for the future facilities. In NPDES permits for other CSO facilities in the King County system, Ecology has considered the effectiveness of the whole CSO capture and treatment system for a particular combined basin. Credit has been given for the aggregate pollutant removal from basin CSO flows occurring at both the local "at-site" CSO treatment facility and by transfer to the West Point treatment plant. The proposed Denny CSO project will operate in much the same fashion, by transferring approximately half the annual volume equivalent to approximately half the annual pounds of pollutants to the West Point plant, where the flows will usually receive secondary treatment. Considering the typical efficiencies of the West Point plant during the time of CSO transfer at least half of the CSO annual pollutants will be removed.

Project Objectives

The objective of the Denny Way/Lake Union CSO Control Project is to meet current federal and state requirements for control of the City of Seattle CSO discharges into Lake Union and control of the County's Dexter CSO to Lake Union and Denny Way CSO to Elliott Bay.

The project has been developed jointly by the County and City because of the close relationship between the two systems in the Lake Union and Denny Way areas. Although the City and County could have each addressed their CSOs in separate projects, independent solutions might have aggravated problems for the other jurisdiction and likely would have resulted in higher total costs for ratepayers. Therefore, the County and City worked cooperatively on a feasibility study for a

combined project in the early 1990s and signed a Memorandum of Agreement in 1995 to jointly implement a multiphase project to address these issues.

Proposed Facilities

This section summarizes the planning process used to develop the proposed facilities, then provides details on the preferred system configuration and its operation, the system flows that will be handled, and the system performance and design criteria that will be met.

Evaluation of Alternatives

Project alternatives were evaluated in a number of iterations to arrive at the recommended project components and operation. The goal of these evaluations was to determine the most cost-effective CSO control method that would comply with the applicable regulations and provide the greatest water quality benefit to Elliott Bay and Lake Union.

The initial evaluations involved three basic approaches to CSO control: 1) sewer separation, 2) onsite CSO treatment and discharge into Elliott Bay, and 3) storage during excess flow conditions, followed by conveyance to the West Point Treatment Plant. Six alternative system configurations were grouped within these three approaches, each focusing on different aspects of the CSO requirements. All of the alternatives except sewer separation included construction of a storage and conveyance tunnel under Mercer Street, plus various new pipelines for rerouting and combining flows. These alternatives were then evaluated with respect to treatment performance, cost, technical feasibility and reliability, and environmental factors.

The evaluation showed that the sewer separation (Alternative 1) was the second most expensive and the most disruptive approach to CSO control. Although partial separation would decrease the total CSO volume discharged, the volume of untreated stormwater discharged to Lake Union and Elliott Bay would actually increase. Partial separation was eliminated from further consideration.

Alternatives 2, 3, and 4 were in Group 2, onsite CSO treatment and discharge. With these alternatives, treated discharges to Elliott Bay would receive floatable material removal, solids removal, and disinfection prior to discharge through a new Elliott West Outfall. In addition, flows would be dechlorinated to meet chlorine residual water quality limits. These Group 2 alternatives differ according to the treatment requirements each uses as its basis of design. Alternative 2 addresses the requirements of the federal CSO control policy. Alternative 3 is based on an interpretation of state regulations for intermittent CSO flows. Alternative 4 would comply with guidance developed for continuous effluent discharges.

The Group 3 alternatives (Alternatives 5 and 6), which would provide storage, then treatment at West Point, would achieve regulatory compliance by assuming that the CSO flows would experience 85 percent removal of TSS at the treatment plant. The difference between these two alternatives is that Alternative 5 would meet only the federal requirements for annual untreated CSO discharges (no more than four

untreated discharges per year), whereas Alternative 6 would meet both federal and state (no more than one untreated discharge per year) requirements.

Alternative 3 was selected as the preferred alternative because it meets all state and federal CSO requirements while providing the greatest water quality benefit per dollar invested. Alternatives 2 and 5 were eliminated primarily because they would not comply with state CSO regulations. Alternatives 4 and 6 have the highest water quality benefits in terms of volume or solids reduction, but they also have significantly higher capital and present worth costs than the preferred alternative. With selection of Alternative 3 at a present worth cost nearly $20 million less than the next lowest cost alternative, the dollars saved can be used to fund other CSO control projects in King County and provide a greater overall system benefit.

The preferred alternative was then refined to improve system performance and further reduce costs. As a result of this refinement, the final system configuration includes minor variations in size, length, and other physical details from those contained in Alternative 3. However, the final configuration is consistent with the Alternative 3 concept of storage and at-site treatment to control untreated discharged to one event per year. Additional engineering was performed on alternative locations for the new CSO outfall, alternative depths for extending the existing outfall, and gravity effluent discharge versus pumped effluent discharge. The refined alternative was then further modified following selection of design consultants and a program management consultant. The following section describes the modified preferred alternative proposed for implementation.

Preferred Alternative

System Configuration

The following new facilities are proposed in the Denny Way/Lake Union CSO Control Project (Figure ES-2):

- Connection with improved City System. The City's improved conveyance facilities on the south and east sides of Lake Union will be connected to the new County CSO facilities. Required facilities include a structure located at Valley Street and Fairview Avenue North that will divert high flows to the CSO tunnel, and a pipeline along Valley and Broad Streets to the east tunnel portal.

- South Lake Union Conveyance Facilities. Two diversion/regulator structures and three 54- to 84-inch diameter pipelines to convey flows to a new Mercer Street Tunnel.

- Denny Area Conveyance Facilities. Two diversion/control structures and three pipelines to convey flows to the new tunnel.

- Mercer Street Tunnel. A 6,200-foot-long, 14- to 16-foot-inside-diameter storage tunnel extending eastward beneath Mercer Street from Elliott Avenue West to a point near the intersection of Roy Street and Eighth Avenue North. The storage capacity of the tunnel would be approximately 7.2 million gallons (MG).

- Elliott West CSO Control Facility. A 250-million-gallon-per-day (mgd) pump station and CSO treatment system located at the west portal of the tunnel to provide removal of floatables, disinfection, and dechlorination.

- Two Outfalls. 1) A new, 96- to 108-inch-diameter outfall to discharge treated flows into Elliott Bay at a depth of 60- to 70-feet below mean lower low water (MLLW); and 2) extension of the existing 96- to 120-inch-diameter outfall to discharge untreated CSO at a depth of approximately 12-feet below MLLW during extreme events that exceed the system capacity (anticipated to occur about once per year).

A list of facilities and their current specifications is provided in Table ES-1.

Performance and Design Criteria

The project facilities will be designed to meet the performance standards shown in Table ES-1, consistent with state and federal requirements.

Table ES-1.
Performance Standards for Proposed Facilities

Regulatory Requirement or Design Criterion	Performance Standard
Untreated CSO Discharge Frequency	
Elliott Bay	One per year
Lake Union	One per year
Treated CSO Discharge Volume and Frequency to Elliott Bay	1 to 30 per year, 90 percent of events <30 MG
Floatable Materials Control	Significant reduction by a mechanical screen. Removed floatables transferred to Elliott Bay Interceptor for disposal at West Point.
Total Suspended Solids (TSS) Reduction	System-wide reduction greater than 50 percent through CSO treatment at West Point.
Settleable Solids Reduction	Annual discharge reduced by at least 80 percent through CSO treatment at West Point; long-term compliance with effluent standard at Elliott West outfall.
Receiving Water Criteria	
Fecal Coliforms	<400 per 100 mL at end of pipe
	Monthly geometric mean <14 per 100 mL, and no more than 10 percent of samples >43 per 100 mL (at edge of chronic mixing zone boundary)
Toxic Pollutants	Copper – 0.0025 mg/L (acute limit)
	Chlorine – 0.0075 mg/L (0.01275 mg/L end of pipe)

National Pollutant Discharge Elimination System (NPDES) limits equal to the above standards are proposed for the new CSO facilities. They would either be incorporated in a new permit specific to the CSO facilities or be added as provisions to the existing West Point Treatment Plant NPDES permit. A chlorine removal standard for Class A marine waters would also be included, consisting of dechlorination to meet the residual chlorine level of 0.0075 mg/L at the end of the outfall diffuser.

System Operation

The preferred system would have several modes of operation, depending on the quantity of wastewater entering the system, the upstream and downstream conditions, and the tidal elevation. These modes of operation can be summarized as follows:

- Operation during dry weather and small storms
- Tunnel storage
- CSO treatment
- Overflow
- Tunnel drawdown
- Emergency

Table ES-2.
Proposed Facilities and Specifications

Facility	No. of Units	Type	Size/ Capacity
South Lake Union Facilities			
Lake Union Tunnel Regulator		Rein. Concrete	
Lake Union Tunnel CSO Pipeline			72 to 84-in. dia., approx. 700 ft long
South Lake Union CSO Pipeline		Concrete	72 to 84-in. dia., approx. 900 ft long
Valley Street Connection			60 to 72-in. dia., approx. 800 ft long
Central Trunk CSO Pipeline			54 to 84-in. dia., approx. 300 ft long
Denny Way Conveyance Facilities			
Elliott Bay Interceptor Control Structure		Rein. Concrete	
Elliott West CSO Pipeline			72 to 84-in. dia., approx. 2,600 ft long
Elliott West Effluent Pipeline			96 to 108-in. dia., approx. 3,000 ft long
System Drain		Gravity Flow	84 to 96-in. dia., approx. 300 ft long
Dechlorination Pipeline			2-in. dia., approx. 3100 ft long
Mercer Street Tunnel			
Tunnel			Length: 6,200 ft Diameter: 14 to 16-ft Storage Capacity: 7.2-MG Liner: Concrete
Ventilation and Odor Control (East End)		Activated carbon	4.6 air changes/hr (nonstorm) 10 air changes/hr (storm)
Elliott West CSO Control Facility			
Pump Station			174,000 gpm
Wet Well/Dry Well Pumps	6	Variable speed	29,000 gpm (ea)
Effluent Channel and Floatables Control		Fixed screens	
Disinfection Facilities (sodium hypochlorite)	2	Tanks	5,500 gal. (ea)
Dechlorination Facilities (sodium bifulfite)	2	Tanks	5,500 gal. (ea)
Ventilation and Odor Control (CSO Control Facility)		Activated Carbon	12 air changes/hr
Electrical Power Supply			
Main Supply		Broad St. Substation	2.5-3 MW
Emergency Supply	1	Generator	150 kW
Outfalls			
Elliott West Outfall			Length: 490 ft Disch. Depth: 60-70 ft MLLW* Diameter: 96 to 108 in
Denny Way CSO Outfall Extension			Length: 90 ft Disch. Depth: 10-20 ft MLLW* Diameter: 96 to 120 in.

This table is intended to summarize facilities described in Chapter 10. Pipeline and tunnel lengths are rounded to the nearest 100 feet.
* Range of discharge depths is to cover the top of pipe, bottom of pipe and invert elevations.

Dry Weather Operation. Under dry weather conditions, no flow would be diverted into the planned facilities. Flows would continue to flow through the existing Lake Union Tunnel and other conveyance facilities, be directed to the Elliott Bay Interceptor, and be treated at the West Point plant.

Tunnel Storage. During storm conditions, water surface elevations would rise to a point where they exceed established elevations at the Lake Union Tunnel Regulator, Central Trunk Diversion Structure, and/or Denny Way Diversion Structure, and flow would begin to be diverted from these structures into the Mercer Street Tunnel, where they would be stored. After the storm, when capacity is available in the Elliott Bay Inter-ceptor, the stored flows would be conveyed to the West Point Treatment Plant. Tunnel storage would be required during any storm that currently results in an overflow at the Denny Way Regulator Station.

CSO Treatment. Treated discharge would occur when tunnel storage reaches its capacity and no additional flows are being accepted at the Interbay Pump Station. Flow would be pumped from the downstream end of the tunnel into the floatable-control channel. The effluent would flow through mechanical screens to remove floatable materials, then into the effluent channel, where it would be injected with sodium hypo-chlorite for disinfection. From the effluent channel, the treated effluent would flow to the new Elliott West Outfall, where it would be injected with sodium bisulfite to neutralize residual chlorine before discharge into Elliott Bay.

Overflow. The CSO treatment plant capacity is planned for 250 mgd, which is expected to handle a one-event-per-year storm. Larger storm events would cause flows in excess of 250 mgd; the storage/treatment system would not be adequate to entirely handle these storms, and untreated discharge would occur at the Denny Way Regulator Station via the extended Denny Way CSO Outfall. Flows discharged through the outfall extension would not receive floatables control or disinfection. However, discharge would continue through the Elliott West Outfall, with floatables control and disinfection.

Tunnel Drawdown. Following a CSO event, flows stored in the tunnel would be drawn down via pumping to the Elliott Bay Interceptor and conveyance to the West Point plant for treatment.

Emergency Mode. Emergency operation would occur under conditions of severe system overload or system shutdown in part or whole. All regulator gates would open fully except the Lake Union regulator, and most drain and bypass gates would remain closed. The flows would discharge into the Elliott Bay Interceptor and the two Denny Way CSO outfalls without treatment.

Special Issues

Four system features received special attention because of their importance to optimal system operation. These are odor control, tunnel cleaning, chlorination safety, and the Elliott West Outfall location.

Odor control will be provided by carbon scrubbing of hydrogen sulfide at the east portal of the Mercer Street Tunnel and at the Elliott West CSO Control Facility.

The relatively flat gradient of the tunnel will require flushing to remove solids deposited during CSO events. This will be provided by design of a tunnel invert (also called a cunette) to concentrate flows at the bottom of the tunnel, and through tunnel flushing by means of gates that release a large volume of water at the upper end, creating a wall of water that would move along the tunnel, suspend sediments, and carry them to the lower end for disposal.

Chlorine disinfection will be provided by sodium hypochlorite injection at the CSO treatment facility. Dechlorination will be provided by sodium bisulfite injection immediately upstream from the transition structure to the Elliott West Outfall. Because of the importance of minimizing impacts on marine life and protecting the nearby fish pens operated by the Point Elliott Treaty tribes, instrumentation will be incorporated that would deactivate the chlorine feed if the dechlorination system fails.

Alternative locations for the Elliott West Outfall were considered. Locations considered were 1) due west of the CSO control facility just south of the Port of Seattle grain terminal, and 2) due west of the Denny Regulator, at the existing Denny Way CSO location. The Denny regulator alternative provides a number of advantages, including a discharge location farther from the tribal fish pens and Myrtle Edwards Park; avoidance of the grain terminal and the most active portion of the offshore ship anchorage area; and cost-effective incorporation of the new outfall into the shoreline transition structure that must be constructed to extend the existing CSO outfall. In addition, the effluent pipeline that would travel from the control facility to the outfall starting point at the foot of Denny Way can be installed in the same construction corridor as the Elliott West CSO Pipeline. This pipeline also provides chlorine contact time for disinfection, thus eliminating the need for a chlorine contact tank at the control facility site. For these reasons, the Denny regulator location is proposed for the Elliott West outfall.

System Flows and Hydraulics

The peak flows to be handled by the system were obtained by computer simulations of the system for seven candidate design storms. The flows associated with Design Storm 6 were selected to represent the once-per-year storm that served as the basis for designing a system with one untreated discharge per year. In addition, the system's peak hydraulic capacity was examined for flows resulting from sewer design storms including an especially high-intensity storm that occurred November 3, 1978. The system hydraulics were modeled with the proprietary software package XP-SWMM, based on USEPA's Stormwater Management Model (USEPA-SWMM).

Given the modeled flows, discharge of treated CSO flows into Elliott Bay is expected to occur between one and 30 times per year with the proposed facilities. One untreated CSO discharge per year is anticipated into Elliott Bay and one into Lake Union. On the basis of the flow conditions modeled between 1978 and 1997, the average annual volume of untreated discharge in those years would have been reduced from about 600 to 8 MG by the proposed facilities, a reduction of 99 percent.

Environmental Process

Project-level environmental review for the project is being done in compliance with both the National Environmental Policy Act (NEPA) and the State Environmental Policy Act (SEPA). USEPA, as a major federal funding source, is the NEPA lead agency for the project, while King County is the SEPA lead agency. The draft environmental document on the project, published in May 1997, is a joint SEPA supplemental environmental impact statement (SEIS) and NEPA environmental assessment (EA). Public comments on the draft document were accepted from May to July 1997, with a public meeting held on June 12. A final SEIS/EA, incorporating public comments on the draft document and the lead agency responses, will be issued in spring 1998.

The joint environmental document is part of a phased environmental review process by King County that began with a 1985 programmatic EIS on the County's system wide plan for secondary treatment facilities and CSO control. It is also part of a similar process for the City of Seattle that began with a 1988 programmatic EIS for the City's CSO control plan.

Project Implementation

Project Schedule

An overall project schedule was developed for project planning, design, construction, and environmental review. The schedule, illustrated in Figure ES-3, indicates that detailed design would be completed by the end of 1999, and construction of all project components would be completed by 2003.

Permits

A number of permits from federal, state, and local agencies will be required to construct the project. Depending on the final design of the project, required permits might include:

- Army Corps of Engineers Section 404 Permit
- Army Corps of Engineers Section 10 Permit
- Certification of consistency, Coastal Zone Management Program
- Washington Department of Natural Resources Dredge Disposal Permit
- Washington Department of Natural Resources Aquatic Lands Right-of-Way
- Washington Department of Ecology Water Quality Certification
- Baseline Permit for Stormwater
- Temporary Modification of Water Quality Standards
- Washington Department of Fish and Wildlife Hydraulic Project Approval
- Washington Department of Transportation Permission to Occupy State DOT ROW
- King County Industrial Waste Discharge Permit
- Building Permit
- Utilities Permit
- Shoreline Substantial Development Permit
- Grading Permit
- Master Use Permit
- Parks Use Permit
- Street Use Permit
- Notice of Construction and Application for Approval
- Pipeline Crossing Permit

Estimated Costs and Rate Impacts

Estimated costs and rate impacts are summarized for the preferred alternative. Cost and rates for the partial sewer separation and storage alternative (Alternative 2) are also presented in Chapter 12. Although subsequently eliminated, Alternative 2 is presented because it is being carried through the EIS process and this alternative serves as a good indicator of "worst case" project costs.

Each fiscal year, the King County budget process establishes the monetary requirements for the operation of the sewage treatment system. These requirements include administration, operating, maintenance repair/replacement, necessary capital reserves and the requirements of bond resolutions. The King County system essentially provides "wholesale" sewer service to cities, sewer districts, and water districts in the Seattle metropolitan area. The cities and districts provide "retail" service to their customers.

For 1998 and 1999, the established King County sewer rate is $19.10 per month per residential customer. This rate captures the impact from all King County wastewater capital projects including the Denny Way project and ongoing operating expenditures. Because the Denny Way/Lake Union CSO Control Project receives no money from the State Revolving Fund, there are no impacts related to this fund to present.

This project has been awarded a $35.0 million Infrastructure Grant by the USEPA. King County and the City of Seattle share this grant, and $28.5 million is reserved for Phases 2, and 3/4. The effect of this grant is described in the rate impact discussion below and in further detail in Chapter 12.

Table ES-3 summarizes the most probable estimated order-of-magnitude project costs for the preferred alternative escalated through the point of award of all of construction contracts, or 2001. Total estimated project cost including City of Seattle Phase 1 and Phase 2 work is $164.3 million.

The total rate impact for the preferred alternative for 1999 is estimated to be $0.02 of the $19.10 sewer rate, rising to $0.95 – 1.06 of the total rate by project completion in the year 2004. The USEPA Infrastructure Grant of $28.5 million (King County's share of the grant) reduces the rate impact of the Denny Way project by $0.07 in 2000 and $0.27 by the year 2004.

Table 12-4 in Chapter 12 shows the anticipated rate impact on a year by year basis, both with and without the USEPA Infrastructure grant.

Sources of funds for wastewater capital improvement projects include:

- Contribution from the operating fund:
    - Customer Charges (sewer rates)
    - Investment Income
    - Capacity Charge
    - City of Seattle CSO Charge
    - Other Misc. Revenue
        - Industrial Surcharge Fees
        - Septic Tank Disposal Fees
        - Sale of By-Products
        - Misc. (small amounts)
- Capital Fund Sources:
    - Proceeds from Bond Sales
    - Short-Term Borrowing
    - Other Capital Revenues (non-operating and capital revenues)

TableES-3

Estimated Project Costs

Alternative 1 - CSO Storage and Treatment (Preferred Alternative)

Capital costs in millions of dollars at time of expenditure

	Phase 1 (Seattle)	**Phase 2** (Seattle)	**Phase 3/4** (King County and Seattle)	**Total Project**
Estimated Construction Cost Construction Costs including Contingencies and Sales Tax	$12.8	$4.4	$104.8	**$122.0**
Estimated Non-construction Costs Engineering, Administrative and Land/Permit Acquisition Costs	3.2	1.7	37.4	**42.3**
Most Probable Project Cost	16.0	6.1	142.2	**$164.3**
Funding Sources				
King County (sewer fees or other normal sources)			94.4	**$94.4**
Federal grant	5.2	1.3	28.5	**35.0**
City of Seattle cost share	10.8	4.8	19.3	**34.9**
Estimated Annual O&M Costs	*$100,000*	*$20,000*	*$501,000*	*$621,000*

Note: The construction cost estimate for Phase 3/4 is based on fourth quarter 1997 dollars (ENR Seattle Construction Cost Index of 6640), escalated to time of construction. The range of accuracy for the Phases 3/4 construction cost estimate is +20% to -15%, thus giving a range of probable construction cost between $89.1 and $125.8 million.